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Article

Neighborhood "Choice Architecture": A New Strategy for Lower-Emissions Urban Planning?

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Abstract
Recent advances in the field of behavioral economics offer intriguing insights into the ways that consumer decisions are influenced and may be influenced more deliberately to better meet community-wide and democratic goals. We demonstrate that these insights open a door to urban planners who may thereby develop strategies to alter urban-scale consumption behaviors that may significantly reduce greenhouse gas (GHG) emissions per capita. We first hypothesize that it is possible, through feasible changes in neighborhood structure, to alter the "choice architecture" of neighborhoods in order to achieve meaningful GHG reductions. We then formulate a number of elements of "choice architecture" that may be applied as tools at the neighborhood scale. We examine several neighborhoods that demonstrate variations in these elements, and from known inventories, we generate a preliminary assessment of the possible magnitude of GHG reductions that may be available. Although we acknowledge many remaining challenges, we conclude that "neighborhood choice architecture" offers a promising new strategy meriting further research and development.

Keywords
behavioral economics; choice architecture; climate change mitigation; greenhouse gas emissions; neighborhood planning

Issue
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1. Introduction

It is increasingly recognized that urban form plays an important role in greenhouse gas (GHG) emissions—by at least one measure, directly affecting up to 30% of all GHG emissions (Hoornweg, Sugar, & Trejos Gomez, 2011; Mehaffy, 2015). However, the ability to vary emissions through changes in urban form has been the subject of considerable controversy by investigators (Dodman, 2011). For example, a paper issued by the National Academy of Sciences (2009) held that the factors of urban form that can be feasibly varied by planners do not offer significant magnitudes of reduction, individually or in combination. Furthermore, the authors held that significant GHG reductions from alterations in urban form are not even feasible in the near term, since urban form changes slowly.

A rebuttal by Ewing, Nelson, Bartholomew, Emmi and Appleyard (2011) argued that the magnitudes of individual factors were under-stated, and that the paper ignored their significant cumulative effects over time. Moreover, precisely because urban form changes slowly, the effects of actions now will persist and accumulate for many decades, magnifying the long-term effects of changes in urban form in the short term.

It is also clear that the variation in GHG emissions per capita varies enormously by country and by city, and it is difficult to explain such magnitudes without recognizing the central role of often dramatic variations in urban form. For example, data assembled by the World Bank (summarized in Figure 1) shows that per-capita inventories of emissions assembled under UNFCC protocols vary between Stockholm, Sweden and the average in the USA by over six-fold. Although the USA is clearly a more geo-

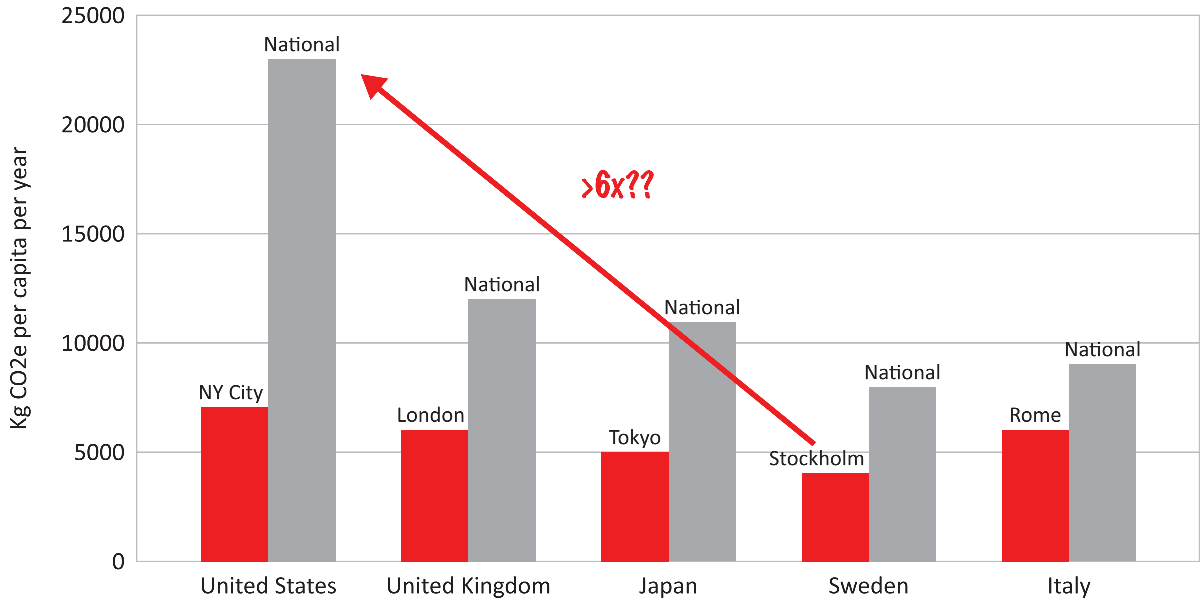

Figure 1. Dramatic differences are revealed between country (gray) and city (red) GHG emissions per capita, reflecting national consumption-based inventories gathered from 2005–2007 and assembled under UNFCC standards. Source: World Bank (2011). The differences do not correlate well with income, climate, national geography, or other factors—but the factors of urban form do show a strong correlation (Mehaffy, 2015).

graphically dispersed country, most emissions occur in activities within cities, not between them (UN-Habitat, 2011), and so it is the form of the cities—not their pattern of dispersal—that is suspect. If we could capture even a portion of that variation, it would represent a sizable reduction in greenhouse emissions per capita.

The role of urban form appears all the more important given that the world is currently experiencing an unprecedented period of rapid urbanization, with potentially profound impacts on emissions (Olivier, Janssens-Maenhaut, Muntean, & Peters, 2013; UN-Habitat, 2011). It seems clear that any significant changes in urban form that can be linked to changes in emissions rates will have a profound effect on emissions in the future.

At the same time, the dynamics of how urban form affects rates of emissions, and how these changes can be altered to achieve significant reductions of emissions, are undeniably complex (Dodman, 2011). Particularly important is the question of consumption behavior and demand. One of the promising topics of investigation has been the opportunity to achieve significant reductions through changes in behavior and consumption, with a notable focus on the household scale (Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009; Gowdy, 2008).

Going beyond the household scale, we might ask the same question at the neighborhood scale, and more broadly speaking, the scale of urban form. Do people tend to consume more energy-intensive, high-emissions products when they live in some types of urban forms than in others, all other things held equal? We already know that they tend to drive more in neighborhoods that are less dense and have more car-dependent transportation systems, for fairly self-evident reasons (Cervero & Murakami, 2010). Can the same logic be extrapolated to other higher-emissions behaviors?

One significant problem is that consumption demand is a highly elastic variable, and a problematic one when it comes to predicting outcomes. For example, the predicted levels of energy-efficient buildings have been shown to vary significantly from their actual performance, in part because anticipated demand has varied far more than expected (Montanya & Keith, 2011; Newsham, Mancini, & Birt, 2009).

One significant problem is the phenomenon of "induced demand". Demand and choice are not static but elastic, and demand can increase as the result of increased efficiency, tending to erase the gains. In transportation, for example, widened roads initially result in smoother traffic flow, but the faster paths draw more drivers, and create "induced demand", erasing the traffic flow benefits of widening projects. In addition, the creation of new route choices, rather than speeding flow, can actually increase congestion, the result of a phenomenon known as "Braess' Paradox" (Sorrell, 2009; Steinberg & Zangwill, 1983).

Similarly, more resource-efficient technologies (like more efficient automobiles) can also produce induced demand and "rebound effect" (Sorrell, 2007). Closely related, the well-known Jevons' Paradox states that as efficiency goes up, cost tends to go down, which tends to result in increased consumption demand. This phenomenon has been observed as an unintended consequence of increased energy efficiency (Polimeni, 2008). From a GHG emissions perspective, the result is often an increase in emissions that erases part or all of the expected gains (Sorrell, 2009).

No less problematic is the inability to deal with behavior in isolation, apart from systemic and cultural influences including psychological and sociological influences (Moloney & Strengers, 2014; Strengers, 2012). Such effects have proven ineffective in the past, leading authors like Strengers to call for a more comprehensive application of theories of social change and policy.

The lesson for those seeking GHG emissions reductions is that variables of urban form, like other variables affecting emissions, cannot be treated in isolation, but need to be treated as part of a comprehensive "systems" approach, sensitive to rebound effect, and Braess-like network influences. We must consider not only urban form, and not only lifestyle and consumption behaviors, but how urban form interacts with and shapes those behaviors in complex and subtle ways.

The challenges posed by these interactive effects may seem overwhelming, but they are hardly without precedent. Medical doctors routinely deal with similarly complex challenges, and over time they have developed successful and efficacious approaches. Indeed, the biological similarities of "organized complexity" in urbanism were described memorably by Jane Jacobs in the last chapter of her landmark *The Death and Life of Great American Cities*, titled "the kind of problem a city is" (Jacobs, 1961). Our challenge, too, is to iteratively develop more effective approaches, looking for successful methodologies that we can apply, refine and further develop (Mehaffy, 2015).

2. Contributions of Behavioral Economics

In a similar way, the more specific challenge of shaping behavior and demand is also a daunting one, but also not without precedent. Those who study complex economic interactions and the psychology of consumer choices have made substantial headway in facing similar challenges in recent years. Most relevant have been the notable advances in the area of behavioral economics and choice (Camerer, Loewenstein, & Rabin, 2011).

Economists, unable to explain behaviors that are not predicted by the "efficient market hypothesis" and other standard economic models, have increasingly turned to psychology for new models (Sent, 2004). In that field it has been found that human beings often must use limited information to make choices, and their ability to make what we might regard as rational decisions are similarly limited—as the Nobel Prize-winning psychologist and polymath Herbert Simon (1956) famously observed. The implication is that the limits of human cognition will distort choices—and the boundaries of these limits, according to Simon, can readily be observed in the psychology of experience, and the structure of the environment in which that experience takes place. Simon (1956) termed this phenomenon "bounded rationality".

The psychologists Daniel Kahneman and Amos Tversky took this work on bounded rationality much further in the intervening years, establishing a robust set of findings in the consequences for decision-making and choice from the limits of cognition, the effects of environmental "availability", and related insights—also garnering a Nobel Prize (Kahneman, 2002).

Building on those insights, in 2008 the behavioral economist Richard Thaler and two colleagues introduced the concept of "choice architecture" (Thaler, Sunstein, & Balz, 2010). They described the importance of the structures in which choices are pre-configured in shaping the actual choices made. This finding (once again the subject of a Nobel Prize) opens the way for those who seek changes in the outcomes of consumer choices to make alterations in the "choice architecture" to do so.

The primary focus of this work to date has been in the area of public policy and consumer choice—for example, influencing healthier eating choices—and in fact, a number of investigators have begun to explore the implications for sustainable resource use and GHG reduction (Johnson et al., 2012; Kallbekken & Sælen, 2013). Some researchers have examined specific tools to apply choice architecture to sustainable transport (Bothos, Mentzas, Prost, Schrammel, & Röderer, 2014). Most famously, the UK government has begun applying so-called "nudge" policies to achieve these and other public policy goals (Young & Middlemiss, 2012). Thus far, however, as far as we are aware, there has been little attention to the potential for application of these tools at an urban scale—the topic we take up here.

In a sense, one can readily observe that commercial businesses already frequently exploit these dynamics, as for example when they place brightly colored candy packaging at the checkout line of a store. On a broader environmental level, retailers and retail consultants have compiled extensive knowledge about the factors that influence decisions of consumers driving or walking past a store to choose to shop there, including display visibility, signage color and the like (Gibbs, 2011). While these urban-scale design changes do not formally exploit concepts of "choice architecture", they exhibit a similar approach to a similar problem.

It must be noted that there is considerable debate about choice architecture and its top-down, potentially manipulative aspects (Selinger & Whyte, 2011). At the same time, many choice architects state that their aim is not to manipulate consumers in hidden ways, but to apply open community decisions about public policies—ideally including the same people who will be affected by those policies, within a democratic and participatory context—and then to find ways to make implementation easier through behavioral economic strategies (Sunstein, 2015). Again, the public policy of healthier eating is a relevant example (Johnson et al., 2012).

More tantalizing for our purposes, behavioral economics suggests a possible path to a shared community goal of GHG reductions from urban form—the opportunity we investigate here. Can we look at the entire neighborhood as a tableau of choice architecture for the residents, amenable to a democratic process of pre-structuring by planners and stakeholders? Can such a strategy be employed to achieve reductions of emissions? If so, what are the potential magnitudes of reductions, and how can they be achieved in practice?

3. Methodology

To explore this possibility, we first examine a number of the most important key concepts of choice architecture, and their current applications within the field. We then consider how these concepts may translate into urban planning methodologies. Next, we consider how such methodologies may be translated into specific emissions-lowering actions at the neighborhood scale. Based upon the prospects for changes to known sources of emissions (e.g., passenger car use), we make an initial assessment of the possible magnitude of reductions based upon available evidence. Finally, we examine concrete examples, in the form of three neighborhoods with known characteristics of urban form, also known GHG inventories. We consider their variations in emissions using the conceptual model of choice architecture, asking whether the model might help to explain some of the currently unexplained variation. We find encouraging (but not conclusive) evidence for that hypothesis. We conclude with a discussion of the promise and pitfalls of choice architecture as a new conceptual strategy for these purposes, and the likely next steps in its subsequent development as a methodology in practice.

4. Elements of Choice Architecture

Thaler and other authors have articulated at least six major tools of choice architecture (Johnson et al., 2012) that might be applied to the planning of neighborhood structure. We list them here, along with their possible application to neighborhoods.

4.1. Create Defaults

Because of the cognitive limits of short-term decision-making, and the "bounded rationality" of human consciousness, humans are prone to choose "default" options that are more cognitively accessible (Kahneman, 2002; Smith, Goldstein & Johnson, 2013). For choice architects, this means that defaults should be established as more prominent and immediate options (Johnson et al., 2012).

Defaults may include both visually prominent features, and features that are more cognitively "available" because they have attention-getting or appealing aesthetic characteristics. This means that visual appeal is one of the important tools in a neighborhood choice architect's toolbox—no less than it is with a product marketer who uses beautiful models to sell its products.

4.1.1. Urban Planning Methodologies

a) Increase visual prominence and visual appeal of a default option. For example, create pedestrian pathways that are larger and more beautiful;
b) Increase cues that signal the default option. For example, add signage, or prominent gateway;
c) Decrease prominence of non-default options, without removing them from a rational decision-making process. For example, place parking lots at the rear of stores, in visually less prominent locations.

4.2. Reduce "Choice Overload"

Consumers are not helped when choices are too numerous to allow a careful evaluation and selection of alternatives (Schwartz, 2004). At the same time, too few alternatives may prevent consumers from finding a truly optimal choice for their varying circumstance. Therefore, an optimal choice architecture would present a range of meaningful choices most likely to meet consumer needs, without overwhelming consumers with irrelevant options (Johnson et al., 2004).

4.2.1. Urban Planning Methodologies

a) Limit the availability of multiple confusing choices, including confusing visual cues. For example, reduce the clutter of automobile-related signage, and make existing pedestrian and bike-related signage more prominent;
b) At the same time, assure a meaningful range of choices based on actual likely need. In the case of automobile-related signage, of course there is likely to be a continuing need for some signage, but it should be as limited as possible;
c) Present the choices in clear and comprehensible forms. Make designs "legible". Make signs clear, simple and easy to read. Place preferred and default choices in clear and visible locations.

5. Increase the Availability of Future Costs and Benefits in the Present

Consumers tend to focus on more cognitively available impacts in the present (Kahneman, 2002; Shu, 2008). Therefore, long-term costs or benefits, such as higher prices or better environmental benefits, must be presented in a near-term form that is more recognizable, e.g., immediate tolls, or awards for environmental achievements, offering immediate tangible benefits (Johnson, et al., 2004).

5.1. Urban Planning Methodologies

a) Provide for immediate payments or economic benefits. For example, increase toll charges, congestion charges, discounts, passes, "green" rewards, and similar financial incentives and disincentives. Reduce delays for public transit users, bicyclists and pedestrians;

b) Make long-term positive actions easier, more convenient, less burdensome or dangerous in the short-term relative to more negative ones (e.g., reduce "switching costs" and "search costs", and other barriers to a change toward more beneficial activities);
c) Make long-term positive actions more pleasurable and more immediately rewarding aesthetically in the short term. For example, provide greater aesthetic pleasures in the moment for walking and cycling, thereby making more "available" the benefits of these long-term low-carbon activities in the short term.

6. Partition Options into More Easily Understood Groups

Consumers are influenced by the way that attributes are grouped or "partitioned", and they tend to pay less attention to attributes that are grouped together (Fox & Rottenstreich, 2003). Therefore, to increase selection of more important attributes, itemize them, while aggregating less important ones (Johnson et al., 2004). For example, the nutritional content of foods might be listed in partitioned groups, with the most beneficial or least beneficial ones listed individually, and relatively inconsequential ones listed under "other ingredients". In addition, complex information can be made more cognitively accessible by partitioning into more easily comprehended units. (See also number 5, "translate attributes into cognitively accessible forms".)

6.1. Urban Planning Methodologies

a) Itemize costs and benefits of activities that have a direct connection to consumer behavior. For example, apply congestion charges per unit of driving distance. Provide simple, direct rewards to those who choose biking or walking, such as specially designed bike racks and pedestrian entrances;
b) Aggregate costs (including time costs) that might otherwise seem more costly. For example, coordinate and combine delays in waiting for transit so that delay times overlap and optimize walking times to coordinate with transit times;
c) Highlight costs and benefits that have important consequences by providing an immediate economic reward or charge in a prominent form. For example, provide a toll road for cars, but a special no-toll path for bicycles and transit.

7. Translate Attributes into Cognitively Accessible Forms

The benefits of a consumer choice may be more visible if the attribute is presented in a "translated" way, i.e., a clearer and more comprehensible way that requires less cognitive effort (Johnson et al., 2012). This may also include translating the attribute into a metric that is more meaningful for the consumer, e.g., a direct pocketbook cost instead of an abstract environmental benefit.

7.1. Urban Planning Methodologies

a) Create pricing mechanisms that translate abstract attributes into direct and simple economic costs and benefits, e.g., tolls, parking charges, congestion charges, etc.;
b) Create aesthetic benefits that reward consumers in the short term for choosing actions with long-term benefits (see, also, section 5: "Increase the availability of future costs and benefits in the present");
c) Provide signage and wayfinding that is clearer and presents alternatives in easier to understand forms, e.g., displaying slow travel times for automobile traffic.

8. Evaluating Potential Emissions Reductions from Choice Architecture at the Neighborhood Scale

We previously published a preliminary evaluation of the features of a neighborhood that relate to the concept of choice architecture, and the potential magnitude of emissions reductions suggested in previous research (Mehaffy, 2015). Here we review these features and assess the potential of choice architecture tools to achieve these reductions.

8.1. Altering the Choice Architecture of Existing Car-Dependent Neighborhoods

We began our earlier assessment by identifying a mature body of research documenting the contribution of vehicular transport (notably personal automobile transport) as significant factors in global per-capita GHG emissions, particularly so in developed countries (Dodman, 2009). As we noted, this factor appears likely to gain in significance as countries like China and India continue to develop car-dependent urban forms (Calthorpe, 2013). To the extent that the "modal split" (the percentage using different forms of travel) can be shifted away from vehicle use and towards walking and/or bicycling, there is a concrete opportunity to achieve measurable reductions in energy and resource consumption, and in GHG emissions per capita, in combination with other opportunities (Pacala & Socolow, 2004).

In addition, the embodied energy and materials in automobiles and infrastructure further increase the average emissions per unit of distance (Mehaffy, 2013). This is because greater vehicle operation and Vehicle Miles Travelled (VMT) on average requires manufacture of a greater number of automobiles, and more construction, maintenance and operation of roadways, all of which contribute to resource consumption and GHG emissions. In addition, roadways and other infrastructure generally remove vegetation and pervious cover, further exacerbating the problem.

We previously cited evidence to suggest that the potential reduction in GHG emissions from feasible changes to transportation behaviors was in the range of 10% (Mehaffy, 2015). This potential reduction occurs primarily as the result of lower driving and more use of walking and transit, or what is known as "modal split". Therefore, if changes to neighborhood choice architecture can have a significant effect on modal split, then such a strategy may assist with achieving per-capita reductions of GHG emissions of this magnitude. But before we can examine changes, let us assess the current choice architecture of *existing* neighborhoods, and the places where changes might be made in accordance with a choice architecture methodology.

It is well known that many existing neighborhoods are "car-dependent", that is, they are designed so that almost all trips are expected to be taken by private automobile (Sohn & Yun, 2009). Under these conditions, it is difficult to avoid increased use of automobiles, and encourage use of alternative modes. In choice architecture terms, these neighborhoods have "created a default" for automobile-based modes of travel. It is very difficult for consumers to switch to another mode, unless this default is altered through an alteration of choice architecture.

The economic literature provides evidence of this phenomenon at work. In work on the effect of "search costs" (Smith, Venkatraman, & Dholakia, 1999) it was shown that consumers may not have adequate information about the full costs versus benefits of continuing a "search" (e.g., pursuing an alternative mode or destination) and may therefore default to the current choice.

In economic literature, the phenomenon of "switching costs" poses a similar barrier: the costs to the consumer of time and opportunity in searching for parking, in maneuvering and securing the car, are generally well known, whereas the benefits of making the switch are often unknown, with the result that the switch is less likely (Dobbie, 1968). The options are *partitioned* in a way that makes the auto-based choices more cognitively available.

We can also see a strong default created within the infrastructure system that is designed to accommodate the automobile and make its use more convenient and pleasurable: the service station "convenience" stores, drive-to shopping centers, drive-in fast-food restaurants, and other related facilities. It is perhaps not surprising that they also exploit the opportunity to present a choice architecture of high-consumption activities to a captive market, using sophisticated behavioral psychology to do so (Chandon & Wansink, 2010; Smith, 2004). There are undoubtedly additional implications for GHG emissions, although this subject is beyond the scope of the present study.

Lastly, we can ask what is the unintended choice architecture of a car-dependent neighborhood on other modes of transportation. There is ample evidence that the engineering changes needed to accommodate automobiles can (and often do) conflict with the safety and comfort of pedestrians and bicyclists (Pucher & Dijkstra, 2003). In turn, there are negative impacts on public transit users, who must walk or bike to and from transit stops. This negative impact increases with the degree of car dependency and use, resulting in an increasingly dangerous and uncomfortable environment for non-auto users. Put differently, auto dependency tends to produce more auto dependency within a feedback cycle. The cycle is accelerated via the reinforcing influences of a changing neighborhood choice architecture.

What are the changes to choice architecture within existing car-dependent neighborhoods that might encourage other modes of travel? We list several here:

a) Provide more *visually prominent walking and bike paths*, with lower burdens and higher aesthetic benefits and pleasurability;
b) Create *pricing mechanisms* that make the costs of automobile travel more cognitively available to consumers, e.g., parking meters, congestion charges;
c) Create more *attractive* and *convenient* transit stops, with more attractive bike and walking paths to them;
d) Where possible, restrict new drive-through facilities and auto-dependent shopping centers, which make driving more *convenient* and a more *attractive default*;
e) Create *economic rewards* for behavior change, including transit passes, discounts, etc.

8.2. Altering Choice Architecture in New Neighborhoods toward More Walkable, Bikeable, Transit-Served Neighborhoods

As the previous discussion suggested, there is evidence that neighborhoods with higher rates of walking and biking show a reduction of longer-distance automobile travel (Ewing & Cervero, 2001). This in turn implies reduced GHG emissions per capita on the order of approximately five percent, an implication that is supported by other studies on city GHG emissions (Cervero & Murakami, 2010; Ewing & Rong, 2008). It thus appears that increasing walking and biking trips through changes in neighborhood choice architecture would serve as a useful GHG reduction strategy (Pacala & Socolow, 2004).

As might be expected, research has demonstrated higher rates of walking in neighborhoods where the design creates a more *convenient* and *attractive default*, even adjusting for other factors such as self-selection (Frank, Saelens, Powell, & Chapman, 2007). In particular, the literature shows a strong correlation between rates of walking and short blocks with high intersection density (Berrigan, Pickle, & Dill, 2010; Leslie et al., 2005). Short blocks lessen the average distance between any two destinations, lowering the barriers to walking. In addition, shorter blocks present a more varied and visually interesting path for walkers and bikers, with more frequent changes of vistas, as compared to longer, unbroken blocks. On the other hand, so-called "dendritic" street patterns can make walking nearly impossible because of the excessively long paths for most trips (Figure 2).

Short blocks and high intersection densities are also associated with greater rates of bicycle use, for the same evident reasons (Winters, Brauer, Setton, & Teschke, 2013). A "permeable" street network shortens average trip distances, and also gives bicycle users a greater opportunity to use alternate streets that are safer and with less traffic. Moreover, such a permeable network is likely to reduce the concentrations of traffic overall and reduce the number of areas of dangerous traffic with which a bicycle might have to contend, further reinforcing the attractiveness of bike travel and its status as a more likely default choice (Mehaffy, Porta, Rofe, & Salingaros, 2010).

Another factor is the importance of well-designed "attractive" and "convenient" sidewalks and bike lanes. Nelson and Allen (1997) showed a correlation between total length of lanes and rates of bicycling. Cao, Mokhtarian and Handy (2007) showed a correlation between safe and well-designed sidewalks and bike lanes, and increased rates of walking and biking with reduced rates of driving.

Following the logic of choice architecture, we must also consider the *aesthetic character* of the streetscape itself, including vegetation, interesting small-scale details, and *pleasurable* user experiences of beauty. As we have seen, a more appealing aesthetic character makes a choice more cognitively available. Following that hypothesis, Cerin, Saelens, Sallis and Frank (2006) presented research that presence of vegetation is associated with higher rates of walking. Other researchers found similar results for both walking and biking (Saelens, Sallis, & Frank, 2003; Wahlgren & Schantz, 2012). Wahlgren and Schantz (2012) also found that user experiences of beauty and greenery both served independently as stimulating factors for bicycle commuting. Since buildings are part of the scenery of bike commuters, this finding suggests that beauty in buildings (as experienced by users)

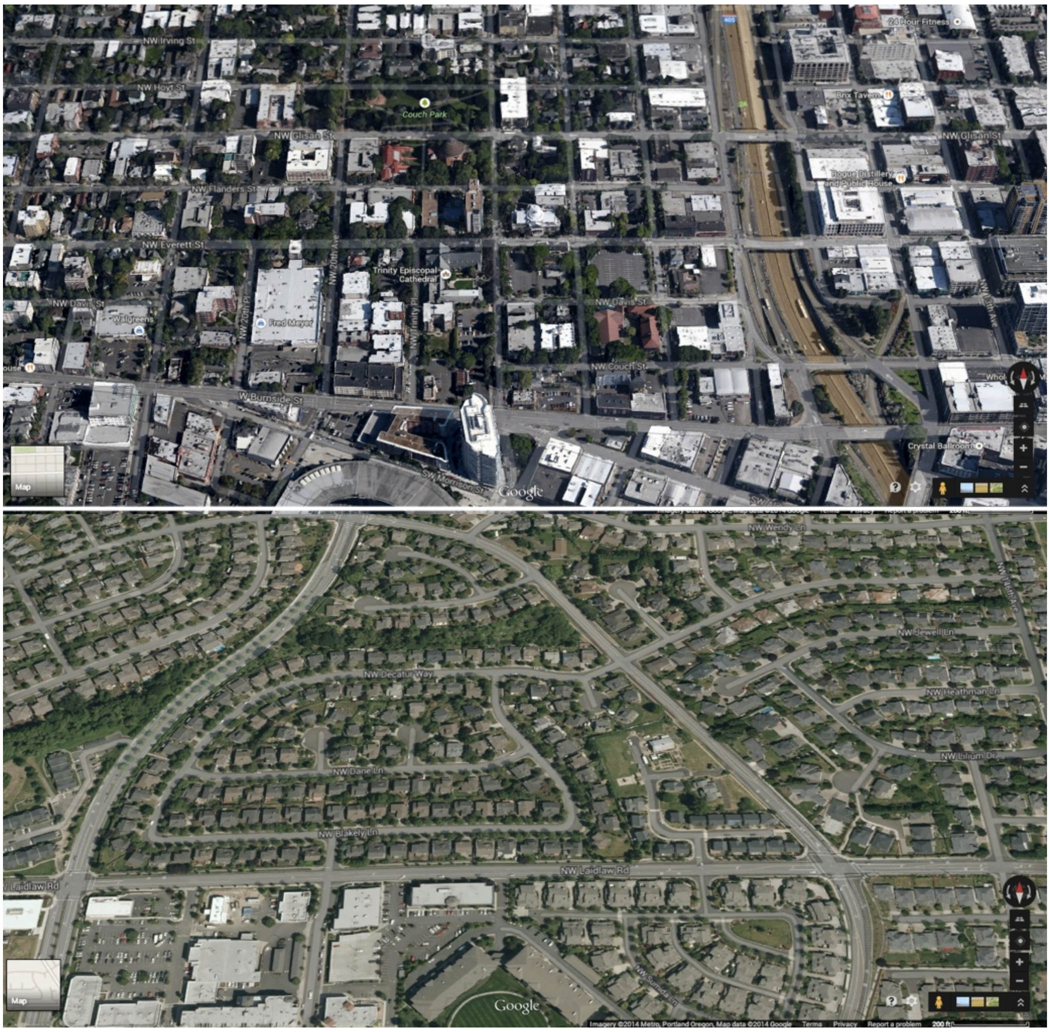

Figure 2. Two very different street patterns shown at the same scale. Above, short blocks and a high density of intersections invites walking. Below, long uninterrupted blocks and "dendritic" or tree-like street patterns make walking unappealing and difficult for most trips (Source: Google Maps).

as well as natural areas can improve the choice architecture to favor bicycle use.

Of course, the question of what specific design characteristics a walker or bicyclist is most likely to find beautiful must also be considered. Cold (1998) surveyed literature concluding that such environmental preferences are not subjective but are rooted in evolutionary history. In particular, the perception of beautiful environments is strongly associated with environments that combine coherence with complexity. This combination affords curiosity, enticement and an opportunity to penetrate hidden layers. Following this logic, neighborhoods with these factors are indeed associated with measurably higher rates of walking and bicycling (Saelens et al., 2003).

In addition, we must consider the influence of environmental affordances as a related concept. For Gibson (1979) we are cognitively more aware of the capacities that are afforded to us by an object in the environment—for example, the "affordance" of a flight of stairs to climb. It follows that the more we make cognitively available the affordances of, say, an attractive walking path, to get to a desired destination, the more likely will be its use. In this sense, Gibson's (1979) theory of affordances is complementary to the theory of neighborhood choice architecture.

In this same vein, we can also ask what are the characteristics of neighborhood choice architecture that will tend to encourage public transit use. There is strong evidence that increased transit use also results in lower per capita GHG emissions, again in the order of perhaps 5% (Mehaffy, 2013; Poudenx, 2008).

A key factor is the walkability or bikeability of pathways to transit stops, which helps to create a default option and *lower barriers*, affecting the willingness of residents to make the initial journey to the transit stop (Cervero & Radisch, 1996; Frank & Pivo, 1994). Also important for "convenience" and "barrier-reduction" is the average distance to the transit stop from possible points of origin for pedestrians (Zhao, Chow, Li, Ubaka, & Gan, 2003).

A second factor affecting transit use, though one that gets little attention, is the attractiveness of the transit facilities and vehicles and themselves. It seems likely that a part of the relative stigmatization of bus travel in particular is in its aesthetic character, and the identity it carries of a "second-class" form of transportation, sometimes disparagingly referred to as a "loser cruiser" (Audirac & Higgins, 2004; Poudenx, 2008). This makes it much harder to establish bus travel as a default option that is *pleasurable*.

Lastly, we found evidence that the immediate environment of the transit stop is important. If it contains other adjacent uses—particularly services that are likely to attract waiting passengers and provide greater safety and "attractiveness"—it is likely to be more frequented (Kim, Ulfarsson, & Hennessy, 2007; Schmenner, 1976). In addition, if there is shelter from inclement weather, this amenity *signals* to potential riders that they will be "comfortable" while awaiting their transport (Law & Taylor, 2001).

As in other areas, these findings lend support to the concept that modifications to the choice architecture of a neighborhood can have substantial impacts on the actual choices made to use public transit.

What are the elements of a strategy of choice architecture for the design of new neighborhoods?

a) *Barriers* to walking and cycling should be lowered, by making smaller blocks, permeable streets and pathways, and a high intersection density. "Dendritic" street patterns should be avoided;
b) *Defaults* should be established for walking and biking, by creating *attractive*, *pleasurable* pathways;
c) The choice of automobile use (or other vehicle to accommodate large loads, the inform, etc) may be preserved as a *non-default option*, while signaling the default of walking and biking with *visually prominent features*;
d) Bus and other transit shelters should be *attractive* and well-planned adjacent to *convenient and safe* active uses, with *prominent signage* indicating the benefits of transit use. Pathways to transit facilities should be prominent, attractive and convenient.

8.3. Other Applications of Neighborhood Choice Architecture

8.3.1. Parks and Recreation

For new neighborhoods as well as existing ones, active outdoor recreation is an inherently low-carbon activity, particularly when it replaces other activities—for example, walking, jogging or using parks, in replacement of driving or performing sedentary activities that consume energy and resources within the home (i.e., watching television, eating snacks, etc.).

There is also evidence that the presence of "attractive" nearby parks, in addition to making convenient recreation available, increases the likelihood of park use (Groth, Miller, Nadkarni, Riley, & Shoup, 2008). Conversely, the absence of such facilities within the neighborhood, even when residents have the means to access more distant ones readily by vehicle, is associated with lower active recreation by residents (McCormack, Rock, Toohey, & Hignell, 2010). By definition, these more distant parks also require more distant travel, often by automobile.

Therefore, to increase the use of parks and recreation as a low-carbon strategy, neighborhood choice architecture might include the following strategies:

a) Create many *convenient* nearby parks that can be *easily reached* by walking or bike;
b) Make them *visually prominent* and *attractive*;
c) Reduce the number of large remote parks that require extensive travel to access. Consider charging *user fees* and/or *parking meters* for their use.

8.3.2. Neighborhood Housing Types

As we noted in our previous research, the design of neighborhoods inevitably affects and limits the design of housing, in part from the size of lots, the provision for attached housing, and indirectly, the size of homes. In turn, these factors may greatly affect domestic consumption patterns, as we discuss below. This is an immature promising area for further research.

First, we can find abundant evidence that the size of homes and lots plays a major role in consumption demand (Ewing & Rong, 2008). In addition to the evident reduction of space required to light, heat and cool the home, residents also have more limited space in which to install high-consumption household and backyard goods. Residents who "downsized" homes do have a lower demand profile (Erickson, Chandler, & Lazarus, 2012).

A related finding is that residential water use is significantly lower in more compact neighborhoods with smaller homes (Chang, Parandvash, & Shandas, 2010; House-Peters, Pratt, & Chang, 2010). Larger-lot suburban residents often have large areas of lawn requiring watering, and they may also have other behaviors associated with high water consumption, e.g., washing of cars (Corbella & Pujol, 2009). The use of water carries implications for GHG emissions in two ways: a) water pumping, storing and purifying requires energy that typically generates GHG emissions; and b) rates of water use tend to correlate with rates of energy used in activities that consume water, such as clothes washing, water heating, lawn care, and other household activities.

At the same time, more work is needed to integrate models of household sources of consumption in relation to regional sources of production (Baynes, Lenzen, Steinberger, & Bai, 2011). For now, it seems very likely that the home itself creates its own "domestic choice architecture" favoring greater per capita consumption and greater GHG emissions (Høyer & Holden, 2003). The lesson for our purposes is that neighborhood form creates the context in which this household-scale choice architecture occurs, and shapes it through a number of ways (including, most obviously, the process of development and the consumer choices it generates).

8.3.3. Neighborhood-Scale Food Consumption

Lastly, we should mention intriguing evidence that the structure of a neighborhood has a notable influence on the pattern of food consumption by residents. In turn there are implications for resource intensity of the food consumed, the amount of waste packaging, and contributions to landfills—all of which drive GHG emissions per capita.

We have already discussed the presence of auto-dependent design as a neighborhood default, and the system of shopping that is auto-oriented. There is also evidence that increased driving can in turn create a "cycle of dependence" (Handy, 1993) in which more distant regional "volume" shopping centers, "big box", fast-food and other "drive through" convenience retailers, eventually displace smaller, more local retailers. As we noted in previous research, the larger facilities benefit from a captive automobile-based market, in the form of buyers who must, if they are not satisfied with the selection, go to the trouble of returning to their automobiles and initiating the cumbersome process of driving to another facility (Mehaffy, 2015). For this captive market, businesses have become adept at utilizing brightly colored packaging and signage, and high concentrations of salt, fat, sweets and processed foods, which entice buyers to engage in high-consumption purchases (Chandon & Wansink, 2010; Smith, 2004).

We previously discussed examples of positive choice architecture in sidewalk-facing markets that present appetizing healthy food in a way that is visible to pedestrians and bicyclists, creating a very different choice architecture (Figure 3). Of course, it is possible to present unhealthy foods in the same way, but it is notable that the close proximity of the food to pedestrians and bicyclists in effect "levels the playing field" and allows fresh fruit and produce to be shown in a most appealing way.

The link between neighborhood choice architecture and food choice is the most indirect, and therefore the least well established in the research literature. It must be noted that other factors may also work to counter the benefits of more compact, walkable neighborhoods—for example, if their residents have a propensity to eat in restaurants with high levels of food waste. However, the indications are intriguing enough that we believe this topic is worth considering for further research and development.

9. Looking at Actual Neighborhoods and Their Relative Emissions

Finally, we will examine three neighborhood examples with contrasting characteristics of urban form as well as comparative baseline inventory data. Each of the three neighborhoods exhibits distinctly different choice architecture in its urban form. The comparison will help us to see how the conceptual model can be applied to interpret actual variations. It is important to note that other factors certainly contribute to the variations in performance (such as sheer density, for example) but they also illustrate in concrete form how neighborhood choice architecture, at the least, offers us an intriguing hypothesis to account for additional reductions from behavior.

The neighborhoods are included in a study by Nichols and Kockelman (2015) that examined operational and embodied energy for five different neighborhoods in Austin, Texas. The authors used a number of inventory methodologies and data sources to produce a combined inventory of energy consumption. Their study did not include household goods or food consumption, but it did consider transportation, household energy and other forms of consumption.

Figure 3. The choice architecture of healthy food on a street in Oslo, Norway. This urban form assures that many people coming into close contact with the appealing display of food (Photo Credit: Author).

The authors also did not measure actual GHG emissions, but rather, rates of energy consumption. Because energy is a primary driver of emissions, and direct measurements of emissions are generally harder to measure at the neighborhood scale, we use the data on energy here as a reasonable proxy for the magnitudes of differences that we may be able to affect with neighborhood choice architecture, in concert with other strategies. Specifically, we will consider the reductions of energy consumption as they are correlated with neighborhood choice architecture.

For simplicity, we consider three of the neighborhoods from the Nichols and Kockelman (2015) study, which span the widest range of difference in urban form. Since they are all in the central or western Austin area, their socio-economic status, climate, legal and political systems, local energy technologies and building codes, and other factors that might generate variations in consumption patterns, are all comparable or even identical. The only major identifiable variable is urban form.

Figure 4 shows Westlake, a western suburb of Austin where the choice architecture is a very strong example

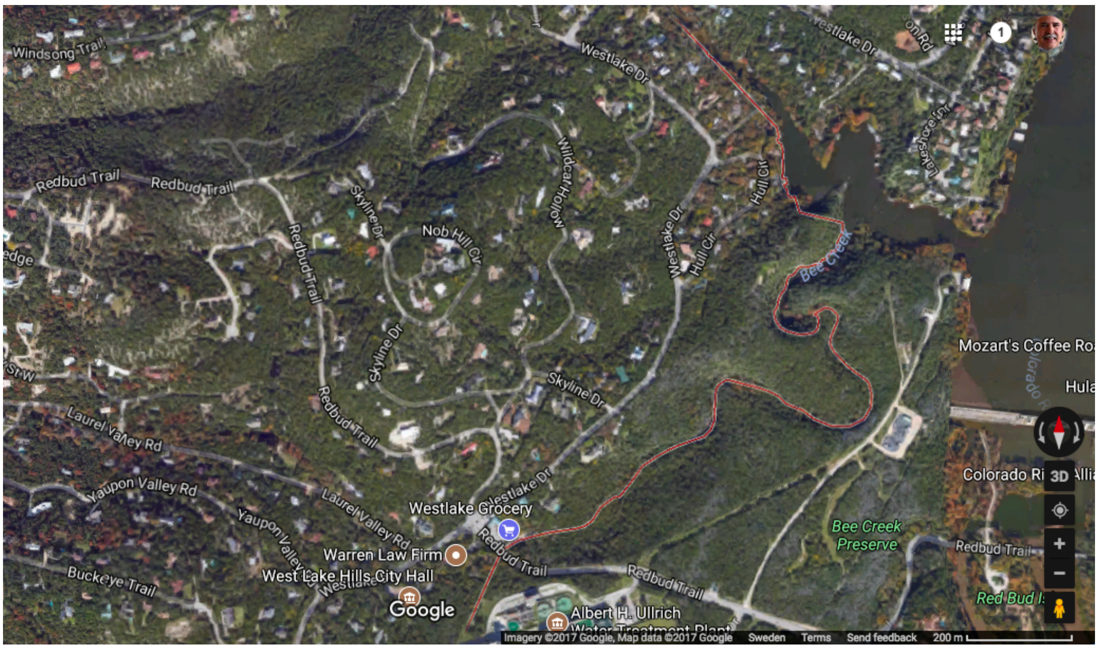

Figure 4. The Westlake neighborhood of Austin, Texas, USA. (Image: Google Maps).

of auto-dependent default. Streets are fragmented and "dendritic", blocks are very large, and there is a low density of intersections. There are no sidewalks, and few people can be observed walking except for recreation. There are no bike paths, and bike users must contend with automobiles on winding, sometimes dangerous roads. Transit service is infrequent and inconvenient, with large distances between stops, and there are no adjacent uses or attractive shelters. Shopping is remote and generally requires extensive driving; from the center of this neighborhood, the closest major shopping facility is approximately 4 miles, and the "Walkscore" website (which measures proximity to shopping among other factors) scores the neighborhood a dismal "4" out of 100 for walkability (Walkscore, 2018). There are no small neighborhood-scale parks. Houses are almost all large detached buildings on large lots.

Figure 5 shows Hyde Park, a more central historic suburb of Austin where the choice architecture is a more mixed example. Streets are inter-connected with a relatively high intersection density, blocks are relatively small, and there are ample sidewalks. Many people can be observed walking and using bicycles. Transit service is convenient and frequent, with large distances between stops, and no adjacent uses or attractive shelters. Shopping is relatively close by, and it is feasible (though not very practical) to shop without a car. There are numerous small neighborhood-scale parks within walking distance. Houses are generally detached, but smaller than typical Westlake houses and in significantly smaller lots on average.

Figure 6 shows the downtown area of Austin, where the choice architecture is the most extreme in the opposite direction from auto-dependent. Blocks are the smallest of the three examples, and there is a very high density of intersections. There are ample sidewalks, and many people can be observed walking and biking. Transit service is frequent and convenient, and many adjacent uses and/or attractive shelters. Shopping is very close by and generally does not require driving. There are many small neighborhood-scale parks nearby, and a large riverfront bark that is also close by to most downtown residences (since it expends in a linear pattern along the river). Houses are almost all large attached apartments or condominiums, and average home size is the smallest of the three neighborhoods.

According to Nichols and Kockelman's (2015) research, the embodied and operational energy of the three neighborhoods is as follows:

As Table 1 shows, the difference between Westlake and Hyde park is almost 30%, and the difference between Westlake and downtown is an eye-popping 53%. Although it is not possible at this point to conclude that neighborhood choice architecture by itself is a causative factor of the bulk of this magnitude—or even to quantify its relative contribution—we can begin to see from this case study how choice architecture, as a conceptual strategy, offers promise as a more integrated method of emissions reduction. At the same time, it is clear that further research is needed within specific neighborhoods, and using more direct comparisons of a range of specific choice architecture techniques.

10. Conclusion

In summary, we have explored the outlines of a framework conceptual strategy for achieving GHG reductions at the urban and neighborhood planning scale, com-

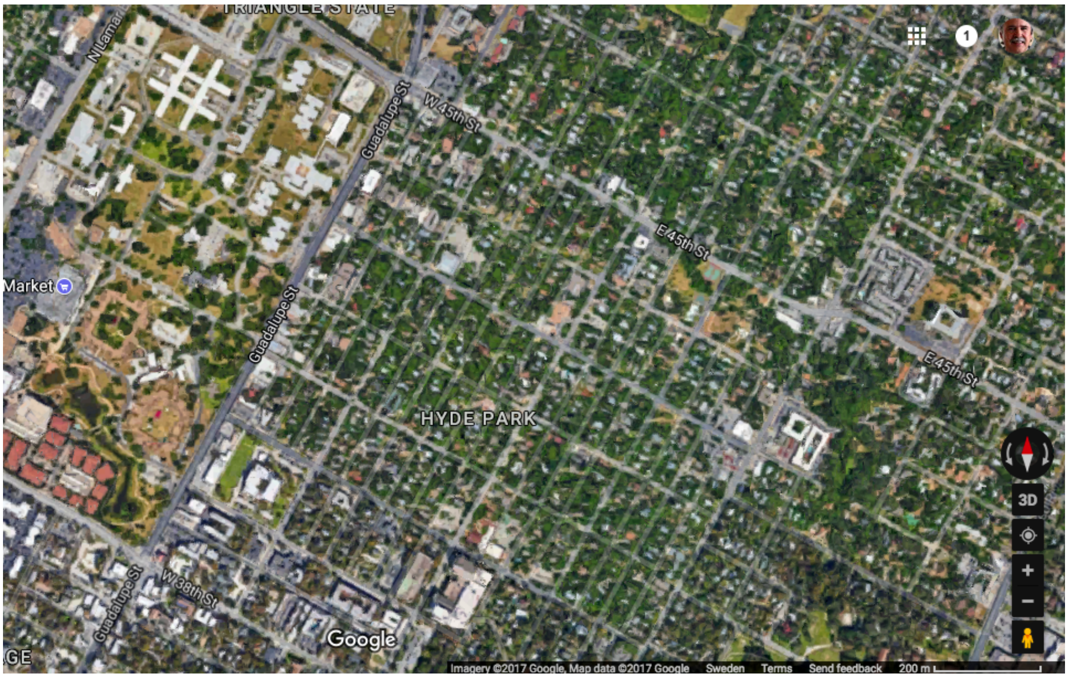

Figure 5. The central Austin, Texas, USA, neighborhood of Hyde Park (Image: Google Maps).

Figure 6. The downtown neighborhood of Austin, Texas, USA (Image: Google Maps).

Table 1. Variation of energy consumption by neighborhood in Austin, Texas, considering transportation and household energy (not including food or household goods). Source: Nichols and Kockelman (2015).

Neighborhood	Operational	Embodied	Combined	Reduction
Westlake	101.0	23.99	124.99	0.00%
Hyde Park	77.18	11.99	89.17	28.66%
Downtown	54,67	3.78	58.45	53.24%

bining the insights of behavioral economics, environmental psychology, urban planning, and public policy. This proposed strategy is aimed at overcoming the well-described limitations of current approaches in treating factors in isolation, and at achieving a more joined-up response between public policy, rational personal choice, and environmental influences in reinforcing desired and necessary day-to-day behaviors.

Although it is too early to verify the potential efficacy of the strategy, this discussion is intended to outline a potential magnitude of benefit sufficient to establish a rationale for further research aiming to provide additional cycles of development, refinement, verification, and wider application. Next steps would include further articulation of individual tools of choice architecture, together with a further strategy for their evaluation, refinement and more widespread implementation. Certainly, a number of significant hurdles remain, including the lack of neighborhood-scale data needed for verification. It will be necessary in further investigation to address these challenges with innovative solutions (for example, "big data" methods of measuring household-scale emissions as part of a research agenda).

It should be noted that this conceptual strategy may also prove effective in achieving other urban planning goals, including promotion of public health, resource conservation and the like. We focus here on GHG emissions reduction, both because it is an urgent issue in its own right, and because it poses most of the same kinds of challenges—complexity, political barriers, economic disincentives—as the other shared policy goals. In all these cases, what is needed is a more unified and effective way of connecting public policy goals to broad changes in individual and city-scale behavior, through the medium of urban form and its choice architecture.

Lastly, the evidence presented here also tells us that, whether we recognize it or not, the choice architecture of *existing* neighborhoods has no less profound impacts – particularly those that are configured around automobile-dependent transportation systems. At the same time, the lens of choice architecture makes us more aware of the impacts of our *own* choices as planners, and the hidden "choice architecture" of professional models and assumptions. Whatever the specific methodologies adopted, it will be a very good thing if we become more conscious of the often-obscure impacts of neighborhood choice architecture—and the often-obscure architecture of our own choices, about the neighborhoods of the future.

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Conflict of Interests

The author declares no conflict of interests.

References

Audirac, I., & Higgins, H. (2004). *From bus shelters to transit-oriented development: A literature review of bus passenger facility planning, siting, and design*. Tallahassee, FL: Florida State University, Florida Planning and Development Lab.

Baynes, T. M., Lenzen, M., Steinberger, J. K., & Bai, X. (2011). Comparison of household consumption and regional production approaches to assessing urban energy use and implications for policy. *Energy Policy*, *39*(11), 7298–7309.

Berrigan, D., Pickle, L. W., & Dill, J. (2010). Associations between street connectivity and active transportation. *International Journal of Health Geography*, *9*(20). doi:10.1186/1476-072X-9-20

Bothos, E., Mentzas, G., Prost, S., Schrammel, J., & Röderer, K. (2014). Watch your emissions: Persuasive strategies and choice architecture for sustainable decisions in urban mobility. *Psychology Journal*, *12*(3), 107–126.

Calthorpe, P. (2013). The real problem with China's ghost towns. *Metropolis POV*. Retrieved from http://www.metropolismag.com/Point-of-View/August-2013/The-Real-Problem-with-Chinas-Ghost-Towns

Camerer, C. F., Loewenstein, G., & Rabin, M. (Eds.). (2011). *Advances in behavioral economics*. Princeton, NJ: Princeton University Press.

Cao, X., Mokhtarian, P. L., & Handy, S. L. (2007). Do changes in neighborhood characteristics lead to changes in travel behavior? A structural equations modeling approach. *Transportation*, *34*(5), 535–556.

Cerin, E., Saelens, B., Sallis, J., & Frank, L. (2006). Neighborhood environment walkability scale: Validity and development of a short form. *Medicine and Science in Sports and Exercise*, *38*(9),1682–1691.

Cervero, R., & Murakami, J. (2010). Effects of built environments on vehicle miles traveled: Evidence from 370 US urbanized areas. *Environment and Planning A*, *42*(2), 400–418.

Cervero, R., & Radisch, C. (1996). Travel choices in pedestrian versus automobile-oriented neighborhoods. *Transport Policy*, *3*(3), 127–141.

Chandon, P., & Wansink, B. (2010). Is food marketing making us fat? A multi-disciplinary review. *Foundations and Trends in Marketing*, *5*(3), 113–196.

Chang, H., Parandvash, G. H., & Shandas, V. (2010). Spatial variations of single-family residential water consumption in Portland, Oregon. *Urban Geography*, *31*(7), 953–972.

Cold, B. (1998). *Aesthetics, well-being and health: Abstracts on theoretical and empirical research within environmental aesthetics*. Oslo: Norsk Form

Corbella, H. M., & Pujol, D. S. (2009). What lies behind domestic water use? A review essay on the drivers of domestic water consumption. *Boletín de la Asociación Geográfica de España*, *50*, 297–314.

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proceedings of the National Academy of Sciences*, *106*(44), 18452–18456.

Dobbie, J. M. (1968). A survey of search theory. *Operations Research*, *16*(3), 525–537.

Dodman, D. (2009). Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories. *Environment and Urbanization*, *21*(1), 185–201.

Dodman, D. (2011). Forces driving urban greenhouse gas emissions. *Current Opinion in Environmental Sustainability*, *3*(3), 121–125.

Erickson, P., Chandler, C., & Lazarus, M. (2012). *Reducing greenhouse gas emissions associated with consumption: A methodology for scenario analysis* (Working Paper 2012, 5). Stockholm: Stockholm Environment Institute.

Ewing, R., & Cervero, R. (2001). Travel and the built environment: a synthesis. *Transportation Research Record: Journal of the Transportation Research Board*, *1780*(1), 87–114.

Ewing, R., Nelson, A. C., Bartholomew, K., Emmi, P., & Appleyard, B. (2011). Response to special report 298: Driving and the built environment. The effects of compact development on motorized travel, energy use, and CO2 emissions. *Journal of Urbanism*, *4*(1), 1–5.

Ewing, R., & Rong, F. (2008). The impact of urban form on US residential energy use. *Housing Policy Debate*, *19*(1), 1–30.

Fox, C. R., & Rottenstreich, Y. (2003). Partition priming in judgement under uncertainty. *Psychological Science*, *14*, 195–200.

Frank, L. D., & Pivo, G. (1994). Impacts of mixed use and density on utilization of three modes of travel: Single-occupant vehicle, transit, and walking. *Transportation Research Record*, *1466*, 44–52.

Frank, L. D., Saelens, B. E., Powell, K. E., & Chapman, J. E. (2007). Stepping towards causation: Do built environments or neighborhood and travel preferences explain physical activity, driving, and obesity? *Social Science & Medicine*, *65*(9), 1898–1914.

Gibbs, R. J. (2011). *Principles of urban retail planning and development*. Hoboken, NJ: John Wiley and Sons.

Gibson, J. J. (1979). *The ecological approach to visual perception*. London: Routledge.

Gowdy, J. M. (2008). Behavioral economics and climate change policy. *Journal of Economic Behavior & Organization*, *68*(3), 632–644.

Groth, P., Miller, R., Nadkarni, N., Riley, M., & Shoup, L.

(2008). *Quantifying the greenhouse gas benefits of urban parks*. San Francisco, CA: The Trust for Public Land.

Handy, S. (1993). A cycle of dependence: Automobiles, accessibility, and the evolution of the transportation and retail hierarchies. *Berkeley Planning Journal*, *8*, 21–43.

Hoornweg, D., Sugar, L., & Trejos Gomez, C. L. (2011). Cities and greenhouse gas emissions: moving forward. *Environment and Urbanization*, *23*(1), 207–227.

House-Peters, L., Pratt, B., & Chang, H. (2010). Effects of urban spatial structure, sociodemographics, and climate on residential water consumption in Hillsboro, Oregon. *JAWRA: Journal of the American Water Resources Association*, *46*(3), 461–472.

Høyer, K. G., & Holden, E. (2003). Household consumption and ecological footprints in Norway: Does urban form matter? *Journal of Consumer Policy*, *26*(3), 327–349.

Jacobs, J. (1961). *The death and life of great American cities*. New York, NY: Random House.

Johnson, E. J., Shu, S. B., Dellaert, B. G., Fox, C., Goldstein, D. G., Häubl, G., & Weber, E. U. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, *23*(2), 487–504.

Kahneman, D. (2002). Maps of bounded rationality: A perspective on intuitive judgment and choice. *Nobel Prize Lecture*, *8*, 351–401.

Kallbekken, S., & Sælen, H. (2013). 'Nudging' hotel guests to reduce food waste as a win–win environmental measure. *Economics Letters*, *119*(3), 325–327.

Kim, S., Ulfarsson, G. F., & Hennessy, J. T. (2007). Analysis of light rail rider travel behavior: Impacts of individual, built environment, and crime characteristics on transit access. *Transportation Research Part A: Policy and Practice*, *41*(6), 511–522.

Law, P., & Taylor, B. D. (2001). Shelter from the storm: Optimizing distribution of bus stop shelters in Los Angeles. *Transportation Research Record: Journal of the Transportation Research Board*, *1753*(1), 79–85.

Leslie, E., Saelens, B., Frank, L., Owen, N., Bauman, A., Coffee, N., Hugo, G. (2005) Residents' perceptions of walkability attributes in objectively different neighborhoods: A pilot study. *Health & Place*, *11*, 227–236.

McCormack, G. R., Rock, M., Toohey, A. M., & Hignell, D. (2010). Characteristics of urban parks associated with park use and physical activity: A review of qualitative research. *Health & Place*, *16*(4), 712–726.

Mehaffy, M., Porta, S., Rofe, Y., & Salingaros, N. (2010). Urban nuclei and the geometry of streets: The 'emergent neighborhoods' model. *Urban Design International*, *15*(1), 22–46.

Mehaffy, M. (2013). Prospects for scenario-modelling urban design methodologies to achieve significant greenhouse gas emissions reductions. *Urban Design International*, *18*(4), 313–324.

Mehaffy, M. (2015). *Urban form and greenhouse gas emissions: Findings, strategies, and design decision support technologies* (PhD dissertation). Delft University of Technology, Delft.

Moloney, S., & Strengers, Y. (2014). 'Going Green'? The limitations of behaviour change programmes as a policy response to escalating resource consumption. *Environmental Policy and Governance*, *24*(2), 94–107.

Montanya, E. C., & Keith, D. W. (2011). LEED, energy savings, and carbon abatement: Related but not synonymous. *Environmental Science & Technology*, *45*(5), 1757–1758.

National Academy of Sciences. (2009). Driving and the built environment: The effects of compact development on motorized travel, energy use, and CO2 emissions. *The National Academies of Sciences*. Retrieved from http://www.nap.edu/catalog/12747.html

Nelson, A. C., & Allen, D. (1997). If you build them, commuters will use them: Association between bicycle facilities and bicycle commuting. *Transportation Research Record: Journal of the Transportation Research Board*, *1578*(1), 79–83.

Newsham, G. R., Mancini, S., & Birt, B. J. (2009). Do LEED-certified buildings save energy? Yes, but… *Energy and Buildings*, *41*(8), 897–905.

Nichols, B. G., & Kockelman, K. M. (2015). Urban form and life-cycle energy consumption: Case studies at the city scale. *Journal of Transport and Land Use*, *8*(3). http://dx.doi.org/10.5198/jtlu.2015.598

Olivier, J. G. J., Janssens-Maenhaut, G., Muntean, M., & Peters, J. A. H. W. (2013). *Trends in global CO2 emissions: 2013 report*. The Hague: PBL Netherlands Environmental Assessment Agency. Retrieved from http://edgar.jrc.ec.europa.eu/news_docs/pbl-2013-trends-in-global-co2-emissions-2013-report-1148.pdf

Pacala, S., & Socolow, R. (2004) Stabilization wedges: Solving the climate problem for the next 50 years with current technologies. *Science*, *305*, 968–972.

Polimeni, J. M. (2008). Empirical evidence for the Jevons Paradox. In J. M. Polimeni, K. Mayumi, M. Giampietro, & B. Alcott (Eds.), *The Jevons paradox and the myth of resource efficiency improvements* (pp. 141–172). New York, NY: CRC Press.

Poudenx, P. (2008). The effect of transportation policies on energy consumption and greenhouse gas emission from urban passenger transportation. *Transportation Research Part A: Policy and Practice*, *42*(6), 901–909.

Pucher, J., & Dijkstra, L. (2003). Promoting safe walking and cycling to improve public health: Lessons from the Netherlands and Germany. *American Journal of Public Health*, *93*(9), 1509–1516.

Saelens, B., Sallis, J., & Frank, L. (2003). Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Annals of Behavioral Medicine*, *25*(2), 80–91.

Schmenner, R. W. (1976). The demand for urban bus transit: A route-by-route analysis. *Journal of Transport Economics and Policy*, *68*(86).

Schwartz, B. (2004). *The paradox of choice: Why more is less*. New York, NY: Harper.

Selinger, E., & Whyte, K. (2011). Is there a right way to nudge? The practice and ethics of choice architecture. *Sociology Compass*, *5*(10), 923–935.

Sent, E. M. (2004). Behavioral economics: How psychology made its (limited) way back into economics. *History of Political Economy*, *36*(4), 735–760.

Shu, S. B. (2008). Future-biased search: The quest for the ideal. *Journal of Behavioral Decision Making*, *21*(4), 352–377.

Simon, H. A. (1956). Rational choice and the structure of the environment. *Psychological Review*, *63*(2), 129.

Smith, T. G. (2004). The McDonald's equilibrium. Advertising, empty calories, and the endogenous determination of dietary preferences. *Social Choice and Welfare*, *23*(3), 383–413.

Smith, N. C., Goldstein, D., & Johnson, E. (2013). Choice without awareness: Ethical and policy implications of defaults. *Journal of Public Policy & Marketing*, *32*(2), 159–172.

Smith, G. E., Venkatraman, M. P., Dholakia, R. R. (1999). Diagnosing the search cost effect: Waiting time and the moderating impact of prior category knowledge. *Journal of Economic Psychology*, *20*, 285–314.

Sohn, K., & Yun, J. (2009). Separation of car-dependent commuters from normal-choice riders in mode-choice analysis. *Transportation*, *36*(4), 423–436.

Sorrell, S. (2007). *The rebound effect: An assessment of the evidence for economy-wide energy savings from improved energy efficiency*. London: UK Energy Research Centre.

Sorrell, S. (2009). Jevons' paradox revisited: The evidence for backfire from improved energy efficiency. *Energy Policy*, *37*(4), 1456–1469.

Steinberg, R., & Zangwill, W. I. (1983). The prevalence of Braess' paradox. *Transportation Science*, *17*(3), 301–318.

Strengers, Y. (2012). Peak electricity demand and social practice theories: Reframing the role of change agents in the energy sector. *Energy Policy*, *44*, 226–234.

Sunstein, C. R. (2015). Nudging and choice architecture: Ethical considerations. *Harvard John M. Olin Discussion Paper Series* (Discussion Paper No. 809, Jan. 2015). Cambridge: Harvard University. Retrieved from http://www.law.harvard.edu/programs/olin_center/papers/pdf/Sunstein_809.pdf

Thaler, R., Sunstein, C., & Balz, J. (2010). *Choice architecture* (Working paper, April 2, 2010). Retrieved from https://ssrn.com/abstract=1583509

UN-Habitat. (2011). *Cities and climate change: Global Report on human settlements*. New York, NY: UN-HABITAT.

Wahlgren, L., & Schantz, P. (2012). Exploring bikeability in a metropolitan setting: Stimulating and hindering factors in commuting route environments. *BMC Public Health*, *12*, 168.

Walkscore. (2018). Walkscore display for Westlake, Austin. *Walkscore*. Retrieved from https://www.walkscore.com/score/2004-s-oak-canyon-rd-austin-tx-78746

Winters, M., Brauer, M., Setton, E. M., & Teschke, K. (2013). Mapping bikeability: A spatial tool to support sustainable travel. *Environment and Planning B: Planning and Design*, *40*(5), 865–883.

World Bank. (2011). Representative GHG baselines for cities and their respective countries. *World Bank*. Retrieved from http://siteresources.worldbank.org/INTUWM/Resources/GHG_Index_Mar_9_2011.pdf

Young, W., & Middlemiss, L. (2012). A rethink of how policy and social science approach changing individuals' actions on greenhouse gas emissions. *Energy Policy*, *41*, 742–747.

Zhao, F., Chow, L. F., Li, M. T., Ubaka, I., & Gan, A. (2003). Forecasting transit walk accessibility: Regression model alternative to buffer method. *Transportation Research Record: Journal of the Transportation Research Board*, *1835*(1), 34–41.

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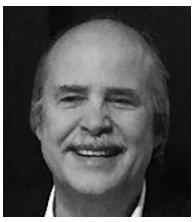

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